



Bangkok Patana School



Cinema 7



GCSE Extension Activity



The following is a taped interview with the security manager, John Larsson, in his office. You are the engineering consultant advising Mr. Larsson about fire evacuation.

Me: Let's take them one at a time.

John: The first task is to develop a computer model that would predict the time for each screen to be evacuated, emptied, if there was a fire alert.

We could test evacuation procedures from Screen7 by filling it with people and then measuring the time for the people to leave. That would be too expensive and dangerous.

We would have to pay people for their time and there could be an accident with lots of people running about.

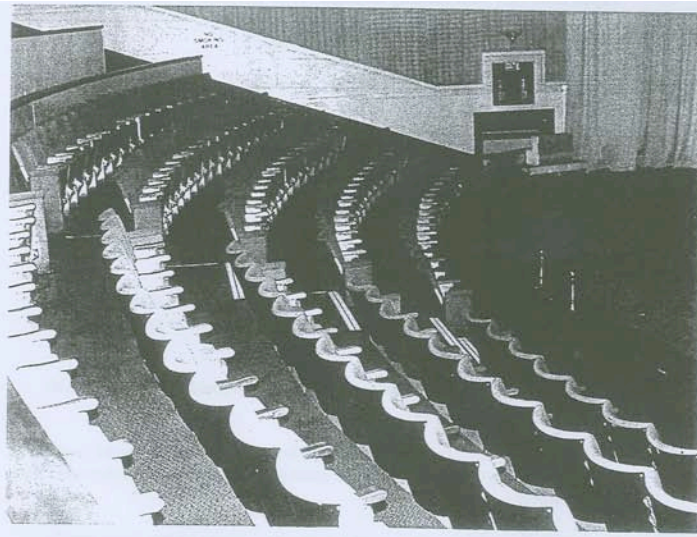
The Maths department at Middlebridge University has designed a model on paper for us. I can give you a copy of this and some of the calculations that they used for screen number 1.

The model allows for people to leave a screen by different routes. Some people will leave by either of the two internal doors and some will leave by the door to the outside. In a real emergency you would not expect everyone to go out of the same door. If people were crowded around the door to the outside then some people would go through the internal doors.

The model also takes into account the fact that some evacuation routes need customers to travel along corridors and down stairs.

Me: What do you want me to do?

John: Use the paper model from the University and build a computer model. You can test it using the data we have for the evacuation of screen number 1 with 200 people. Use the model to predict the shortest time for everyone to leave screen number 4 when it's full of people. You will need to see the new layout of Screen7 which I will give you.



Screen number 6 in the multiplex cinema

Evacuation Model from Middlebridge University

Maximum Number of customers in each screen

Screen no. 1	450
Screen no. 2	120
Screen no. 3	120
Screen no. 4	400
Screen no. 5	90
Screen no. 6	200
Screen no. 7	90

Rules of the model

These times do not change in the model.

Average time to go through a door (single or double) 2 secs

Average time to move down a corridor 5 secs

Average time to move down a staircase 5 secs

How to calculate the time for a given route

Time to go through doors on route	=	No. of people following the route	x	No. of doors on route	x	Average time to go through a door
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Time to travel down corridors on route	=	No. of people following the route	x	No. of corridors on route	x	Average time to move down a corridor
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Time to travel down staircases on route	=	No. of people following the route	x	No of staircases on route	x	Average time to move down a staircase
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Time to evacuate by chosen route	=	Time to go through doors on route	+	Time to travel down corridors on route	+	Time to travel down staircases on route
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Evacuation Routes for Screen1

Location	Exit route	Number of doors	Number of corridors	Number of staircases
Screen1	1	2	0	0
	2	2	1	0
	3	1	0	0

Customers can leave all screens by up to three routes. (See the layout on page 33.)

For screen number one there are three routes

- Route one takes them through an internal door and then out of the main door.
- Route two takes them through an internal door past the ticket counter and out of the main door.
The journey past the ticket counter is counted as a corridor.
- Route three takes customers out of screen no. 1 by the fire exit.

If 200 people were to leave screen number 1 by the following routes:

50 by route 1

50 by route 2

100 by route 3

then

for route one

Time to go through doors on route = $50 \times 2 \times 2 = 200$

Time to go down corridors on route = $50 \times 0 \times 5 = 0$

Time to go down staircases on route = $50 \times 0 \times 5 = 0$

Time to evacuate by chosen route = $200 + 0 + 0 = 200$

for route two

Time to go through doors on route = $50 \times 2 \times 2 = 200$

Time to go down corridors on route = $50 \times 1 \times 5 = 250$

Time to go down staircases on route = $50 \times 0 \times 5 = 0$

Time to evacuate by chosen route = $200 + 250 + 0 = 450$

for route three

Time to go through doors on route = $100 \times 1 \times 2 = 200$

Time to go down corridors on route = $100 \times 0 \times 5 = 0$

Time to go down staircases on route = $100 \times 0 \times 5 = 0$

Time to evacuate by chosen route = $200 + 0 + 0 = 200$

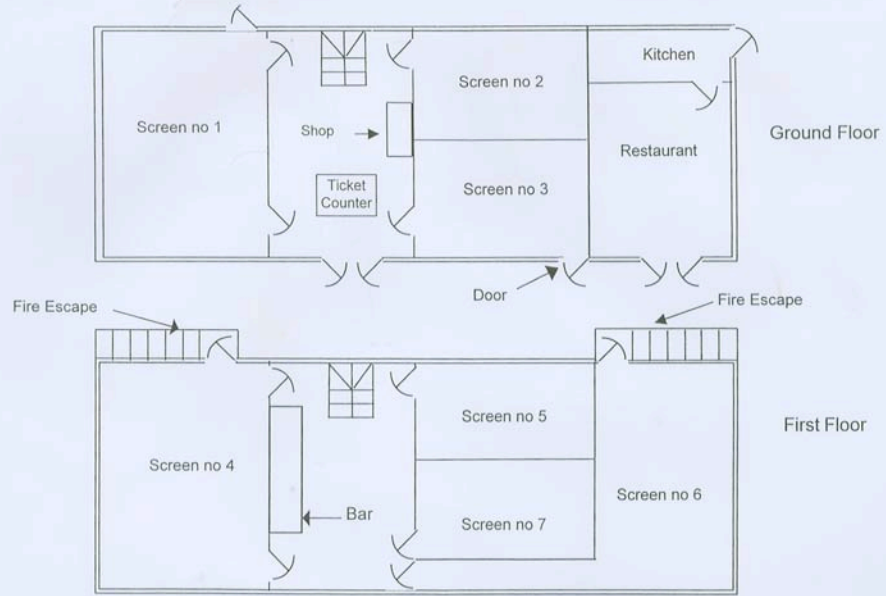
The evacuation time is **450 secs** because this is the longest time

If more people were to leave by routes one and three and less by route two then the evacuation time would be lower.

Trying different numbers of people for each route led to this answer for the shortest evacuation time from screen no. 1 when there were 200 people inside. (This took a long time with a calculator!)

Location	Exit route	People	Total People
Screen 1	1	58	200
	2	26	
	3	116	
Total time to exit by each route	Time to exit (secs)		
	1	232	
	2	234	
	3	232	

The exit time now is **234 secs** not 450 secs since more people are leaving by routes 1 and 3



Screen7: New layout